INDOOR AIR QUALITY ASSESSMENT

High Rock School
77 Ferndale Road
Needham, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Center of Environmental Health
Emergency Response/Indoor Air Quality Program
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Background/Introduction

At the request of a parent, the Center for Environmental Health (CEH) of the Massachusetts Department of Public Health (MDPH) provided assistance and consultation regarding conditions at the High Rock School (HRS), 77 Ferndale Road, Needham, Massachusetts. The request was prompted by reports of possible mold colonization of building materials.

On May 26, 2006 Michael Feeney, Director of Emergency Response/Indoor Air Quality (ER/IAQ), CEH performed a site visit at the HRS. Stephen J. Theall, Superintendent, Mark LaFleur, Director of Facilities, Needham Public Schools and Janice Berns, Director of the Needham Health Department accompanied Mr. Feeney. During the assessment building conditions related to the mechanical ventilation system and water damage were evaluated.

The original building appears to have been built in the late 1940's-early 1950's. An addition was constructed in 1954. As reported by Needham school officials, the HRS was used by the Needham Public Library for several years prior to the 2005/2006 school year. The land around the HRS slopes away from the building towards the north and east (Map 1). The two classrooms on the upper floor of the original building were being used for a pre-school/kindergarten program; all other areas in the HRS were unoccupied at the time of the assessment. Windows in the building are openable.

The building has been previously evaluated by a consultant, Occupational Health & Safety Inc. (OHI) for moisture and mold. In November 2003, OHI conducted mold sampling in room 129. This sampling found "that the airborne mold spore concentrations in room 129 were acceptable on the day of testing (OHI, 2003). No recommendations were made by OHI in this report. OHI re-inspected HRS on March 30, 2006 and made the following observations/recommendations:

- Rooms 14 and 15 had water damage.
- Sink cabinets in rooms 14 and 15 should be removed/replaced.
- The gymnasium had efflorescence on the wall near the stage.
- The cafeteria has floor tile that is damaged due to either water penetration through the slab or from condensation accumulation of the floor during hot, humid weather, thus the use of dehumidifiers was recommended.
- Crawlspaces have water intrusion problems but have mechanical exhaust ventilation (OHI, 2006).

OHI also recommended microbial sampling of the building prior to occupancy.

Methods

CEH staff conducted a water damage/mold evaluation, which included visual observations of the building's interior and exterior.

Results/Discussion

Fresh air in classrooms is supplied by a unit ventilator (univent) system (Picture 1). Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building and return air through an air intake located at the base of each unit (Figure 1). Fresh and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located in the top of the unit. At the time of the assessment, univents were deactivated throughout the building. Univents appear to be original equipment, however updated louver controls appeared to have been installed.

The mechanical exhaust system consists of wall-mounted vents. Airflow into these vents is controlled by an adjustable flue that is connected to a pull chain (Picture 2). A number of rooms were missing pull chains (Picture 2A), rendering the exhaust vents shut. Exhaust vents need to be opened to remove pollutants from the indoor environment.

Microbial/Moisture Concerns

The floor of the cafeteria was examined. Reports of mold related to water damage resulting in a black gum-like substance was observed on and around seams. This material appeared to be mastic that had seeped from beneath the tiles. It was reported by school officials that the expansion of mastic was attributed by parents to the location of the HRS on a wet land or underground river. An examination of U.S. Geological Survey maps of the area indicate the HRS is located on an elevated area, with the ground sloping away from the building to the north and east (Map 1). Therefore, is seems unlikely the rising water table is causing the tile damage in the cafeteria. Water under the slab is more likely to be from poorly draining rainwater and/or condensation.

It could not be confirmed if a vapor retarder was installed beneath the slab to prevent the seepage of moisture from sub-slab areas through the floor. Without a vapor retarder moisture can be drawn upward through the concrete slab by hydrostatic pressure and/or capillary action. Moisture can dissolve alkalis in concrete to form a solution, which can raise pH levels beneath flooring that can lead to the breakdown of adhesives (Donnelly G., 2005).

As reported by school department staff, the floor of the cafeteria becomes slick with water during hot, humid weather. Staining along floor tile seams and cracks in the floor confirm that standing water accumulates on the tiles. The dew point is a temperature that is determined by air temperature and relative humidity. As an example, at a temperature of 70° F and relative humidity of 63 percent indoors, the dew point for water to collect on a surface is approximately 58 ° F (IICRC, 1999). Therefore, any surface that has a temperature below 58 ° F would be prone to condensation generation under these temperature and relative humidity conditions. Surfaces in direct contact with soil (e.g., foundations) will tend to have a surface temperature significantly lower the other building components. If the floor temperature has a similar surface temperature to that measured during the assessment, it is likely that condensation is a likely source of water slicking the floor.

In the rear of the HRS is a tarmac/courtyard (Map 2). It appears that part of the tarmac slopes *towards* the west wall of the cafeteria (Picture 3). Opportunities for water penetration through the building envelope were observed along the exterior wall/tarmac junction of the gymnasium/cafeteria wing and other areas of the school. Plants were noted growing in the junction between the exterior wall and the tarmac (Picture 4). Shrubbery growing immediately adjacent to the exterior wall brick was noted along the building foundation (Picture 5). Plants/shrubbery growing directly against the building can serve as a possible source of water impingement on the exterior curtain wall. These conditions can produce means for water to penetrate below grade areas, such as basements and crawlspaces. In some cases, roots can work their way into mortar and brickwork causing cracks and fissures. Over time, this process can undermine the integrity of the building envelope by providing a means of water entry into the building through capillary action (Lstiburek & Brennan, 2001).

A large number of cardboard boxes were stored on the floor of the cafeteria. These containers can be susceptible to mold colonization if repeatedly moistened by condensation. The US Environmental Protection Agency (US EPA) and American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2000; ACGIH, 1989). If these materials are not dried within this time frame, mold growth may occur. Once colonized, the cleaning of water-damaged porous materials cannot be adequately cleaned to remove mold growth.

Damaged floor tile was also noted in room 15 (Picture 6). Of significance is the location of a retrofitted accessibility ramp that exists along the western exterior wall of the HRS (Picture 7). The exterior door connected to the accessibility ramp is covered by a peaked roof that does not have a gutter/downspout system. Half of the peaked roof directs water to a cement–lined pit at the base of the exterior wall. This type of structure is typically used to provide natural ventilation for crawlspaces. It is important to note that the pit is roughly aligned with the damaged floor tile in room 15. It is likely that the heavy rains of the past several months resulted in water penetrating into the crawlspace through this vent creating the tile damage.

Efflorescence was observed on interior walls at the rear wall of the stage (Picture 8) and in one restroom. Efflorescence is caused by water penetration through brick, dissolving minerals within the brick as it flows through. The water evaporates leaving a dry white residue. While efflorescence is a characteristic sign of water penetration, it is not mold growth. The presence of efflorescence can indicate that water is penetrating through the exterior wall system. Paint consists of carbon, which can serve as a mold growth medium. Because of the location of the efflorescence on the stage wall, it may be advisable to remove paint and leave the concrete bare in order to readily observe future water penetration.

Water damage was noted on brickwork on the south exterior wall (Picture 9). A gutter/downspout system should be installed below the short roof/exterior wall junction to direct rainwater away from the building to prevent chronic water exposure to brickwork.

Several classrooms have sinks with a seam between the countertop and wall (Picture 10). If not watertight, water can penetrate through this seam. Water penetration and chronic moisture exposure can cause porous materials to swell and serve as a medium for mold growth.

The building has a mixture of different window systems in classrooms. The majority of windows consist of fixed glass blocks with openable windows. In some classrooms, exterior surfaces of glass window blocks were either broken or cracked as a result of vandalism (Picture 11). The window system in each classroom with broken glass blocks was examined for water penetration. No water damage through the window system was identified. However, over time, damage to blocks can lead to water penetration and serve as a potential source of microbial growth. Standing water in these blocks can also stagnate, leading to bacterial growth and possible nuisance odors.

Installation of window mounted air conditioners (WACs) can provide a possible means for water penetration into the building. Spaces were seen around materials used to install WACs (Picture 12), which can allow water, drafts and insects into the building.

Other Concerns

As noted by school department staff, the damaged tile in room 15 contains asbestos and should be properly remediated in a manner consistent with asbestos abatement laws. At the time of the assessment, the room where these tiles were located was not accessible to children in the building and therefore does not likely to pose a health concern unless further breakage or pulverizing of the tile occurs. Needham school officials reported plans to repair the damaged floor tiles during the summer 2006 break.

A filter installed in one univent was not the correct size for the unit (Picture 13). In addition, holes in the univent cabinet can allow for air to bypass the filter (Picture 14). In order to decrease aerosolized particulates, properly-fitted filters should be installed and all cabinet holes above the filter should be appropriately sealed. The dust spot efficiency is the ability of a filter to remove particulates of a certain diameter from air passing through the filter. Filters that have been determined by ASHRAE to meet its standard for a dust spot efficiency of a minimum of 40 percent would be sufficient to reduce airborne particulates (Thornburg, 2000; MEHRC, 1997; ASHRAE, 1992). Note that increased filtration can reduce airflow produced by increased resistance, or pressure drop. Prior to any increase of filtration, a ventilation engineer should evaluate each univent to ascertain whether it can maintain function with more efficient filters.

Classrooms have bubblers which are not used (Picture 15). It appeared that no water had been poured into these drains recently. Without draining water, the drain traps can dry, resulting in the loss of the airtight seal created by a wet trap. A dry trap can result in sewer gas backing up into the building under certain circumstances. In addition, the location of these bubblers near classroom exhaust vents may result in odors being drawn into classrooms. Sewer gas can be irritating to the eyes, nose and throat.

Conclusions/Recommendations

The conditions within the HRS appear to be repairable. The areas where water damage occurred did not contain materials that would likely sustain mold colonization and were free of visible mold and associated odors. As reported by OHI, water had accumulated in the crawlspaces. As a remediation step to prevent possible mold and spore migration into classrooms from the crawlspace, utility pipe holes within univents were sealed with a foam insulation material (Picture 16). This sealing would prevent the draw of air and moisture from the crawlspace during the operation of the univents. School officials also reported that both the gymnasium and cafeteria will not be used by students during the next school year (2006-2007). In view of the findings at the time of the inspection, the following recommendations are made:

1) Implement all recommendations made in the OHI report (OHI, 2006).
2) Repair floor tiles as needed in a manner consistent with federal and Massachusetts asbestos abatement laws and regulations.
3) Secure the entrances to the gymnasium and cafeteria to prevent use by building occupants.
4) Install a gutter/downspout system for the roof over the accessibility ramp and under the roof edge in the area shown in Picture 9, to prevent excess water exposure to the exterior wall. Ensure that the downspout drains water at a point that is at least 5 feet away from the exterior wall of the building.

5) Take steps to prevent prolonged moisture contact with the foundation. These steps may include:

   a) Removing foliage, gardens and mulch to at least five feet away from the foundation.

   b) Improving the grading of the ground away from the foundation at a rate of 6 inches per every 10 feet (Lstiburek, & Brennan, 2001).

   c) Installing a water impermeable layer on ground surface (clay cap) to prevent water saturation of ground near foundation (Lstiburek, & Brennan, 2001).

6) Examine the feasibility of reestablishing the slope of the tarmac surface of the courtyard to drain rainwater away from the exterior wall of the cafeteria.

7) Remove all vegetation from the exterior wall/tarmac seam and seal all joints around the building.

8) Reseal holes and cracks in tarmac (Picture 11) and wall/tarmac junction with a water impermeable sealant.

9) Seal abandoned/unused water bubbler drains. If not already done, shut off water supply to abandoned bubblers to prevent accidental flooding.

10) Appropriately seal all spaces around window-mounted air conditioners.

11) Seal all holes in the walls of the univent air handling cabinets to limit filter bypass. Double sided, foil faced insulation with adhesive can be applied in a manner to create an airtight seal.

12) Seal walls in the rear of each univent cabinet and floor holes to prevent air draw from the exterior wall cavity and crawlspace, respectively. Seal the seams and holes in the crawlspace access hatches with duct tape.

13) Ensure that filters in univent are the appropriate size for each univent. Each filter should fit flush within the filter rack.

14) For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

15) Examine the feasibility of repairing or replacing damaged glass block windows. Inspect and repair/replace caulking around window frames to prevent water penetration. Repair water damaged windowsills, walls and wall-plaster. Examine these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.

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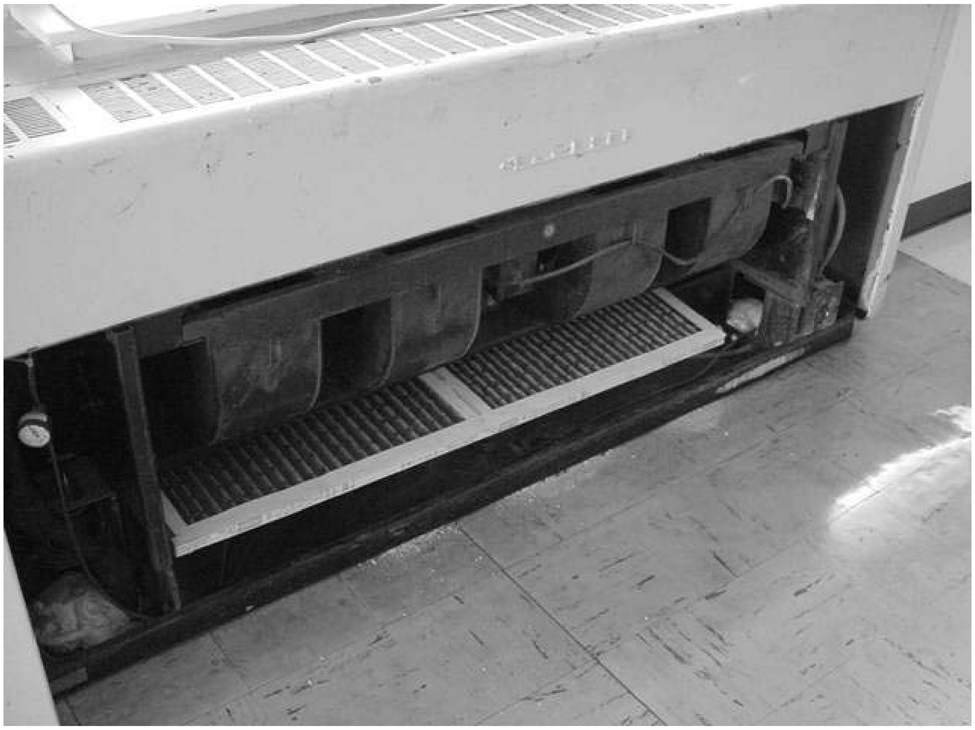
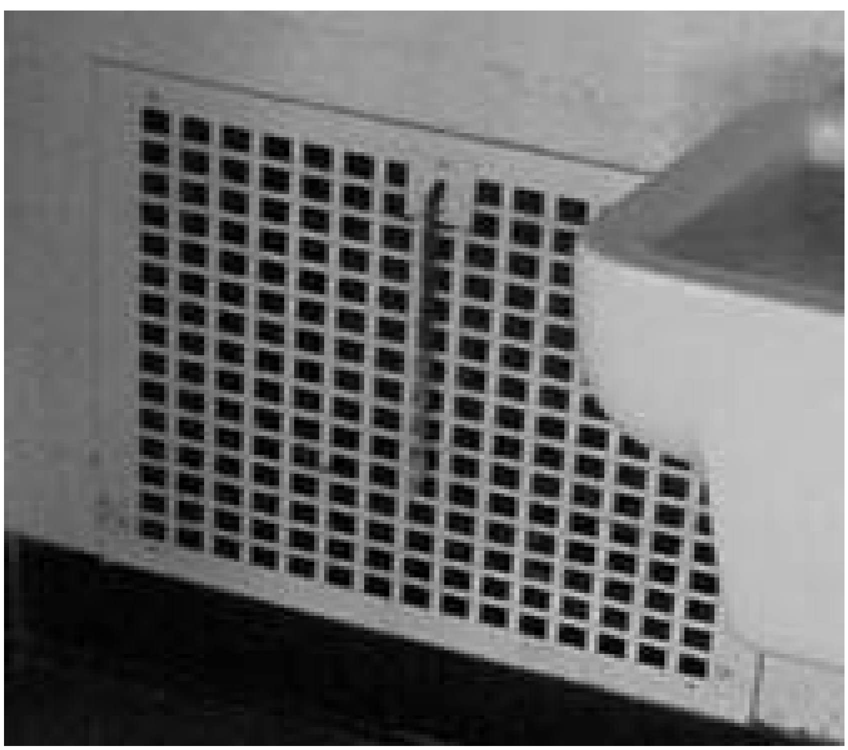
Picture 1



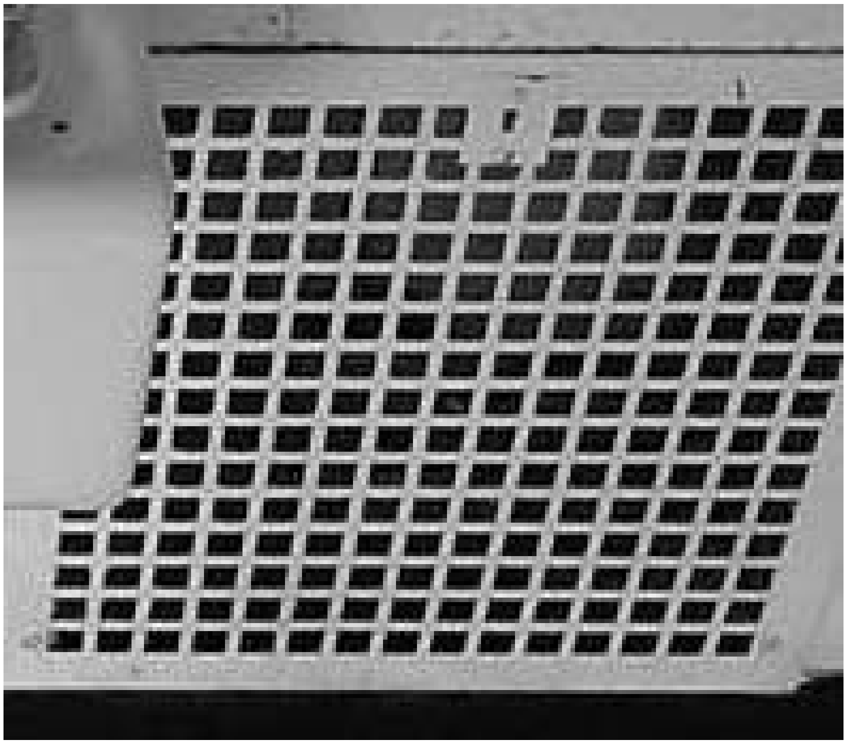
Univent

Picture 2



Exhaust Vent with Chain in Place

Picture 2A



Exhaust Vent, Note Chain Missing From Notch, Indicating Closure of the Louver

Picture 3

Tarmac Outside Cafeteria Sloped towards the Exterior Wall

Picture 4

Example of Plants Growing in the Junction between the Exterior Wall and the Tarmac, Note Holes and Cracks in Tarmac.

Picture 5

Shrubbery along Edge of Exterior Wall

Picture 6

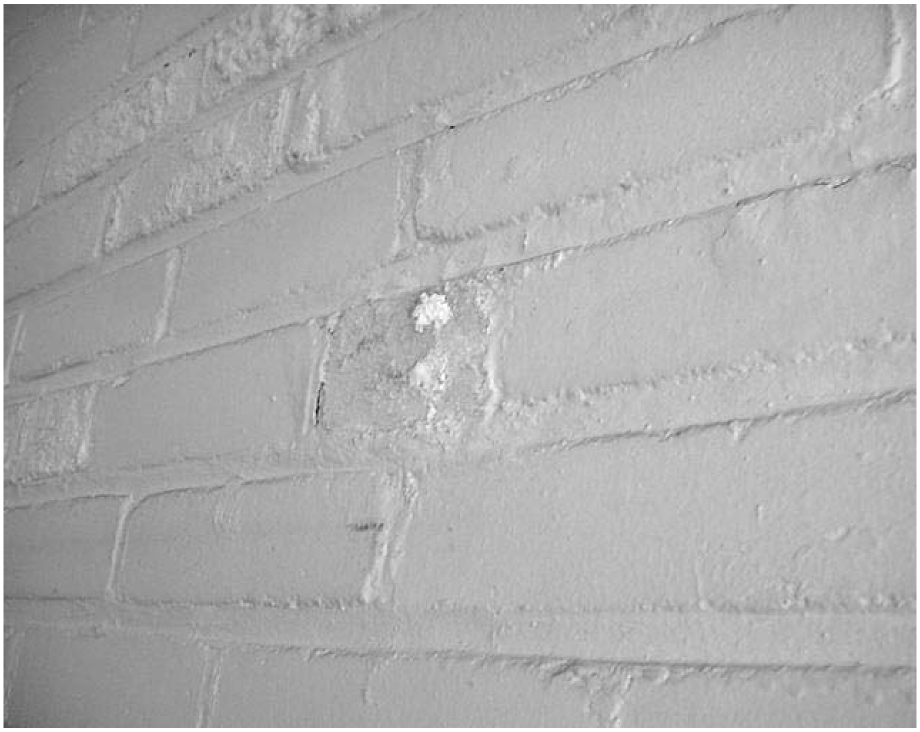
Damaged Floor Tiles in Room 15

Picture 7

Crawlspace Vent

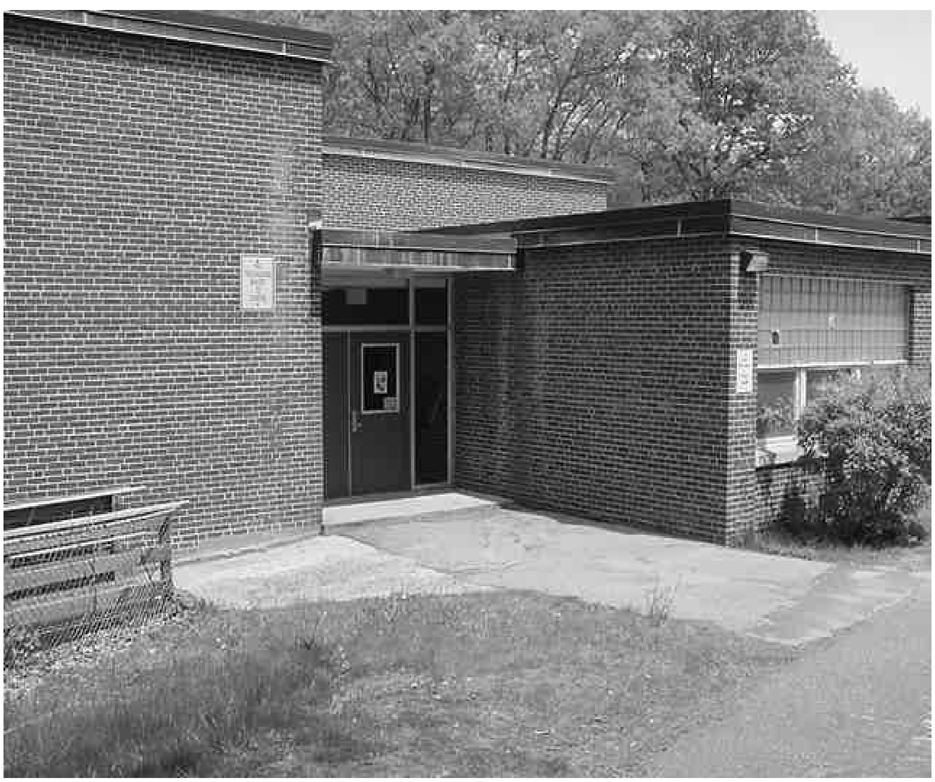
Roof over Access Ramp, Note no Gutter/Downspout on Roof Edge and the Cement Lined Crawlspace Vent beneath the Roof Edge.

Picture 8



Efflorescence on Rear Wall of Stage

Picture 9



Water Damage to Exterior Wall from Roof Rainwater Run-Off

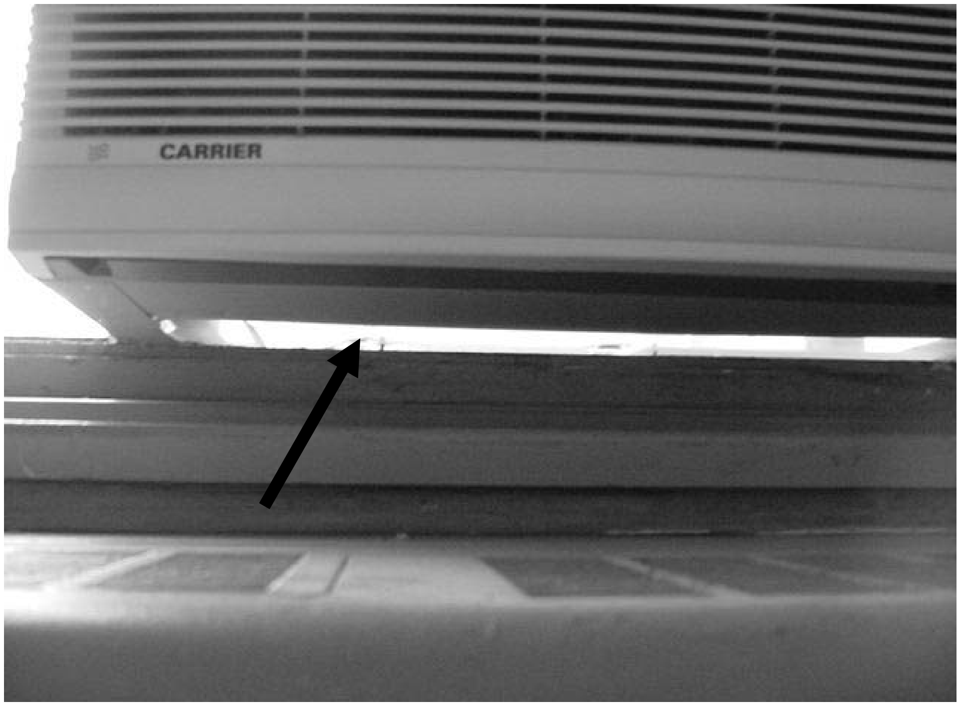
Picture 10

Water Damaged Sink Top

Picture 11

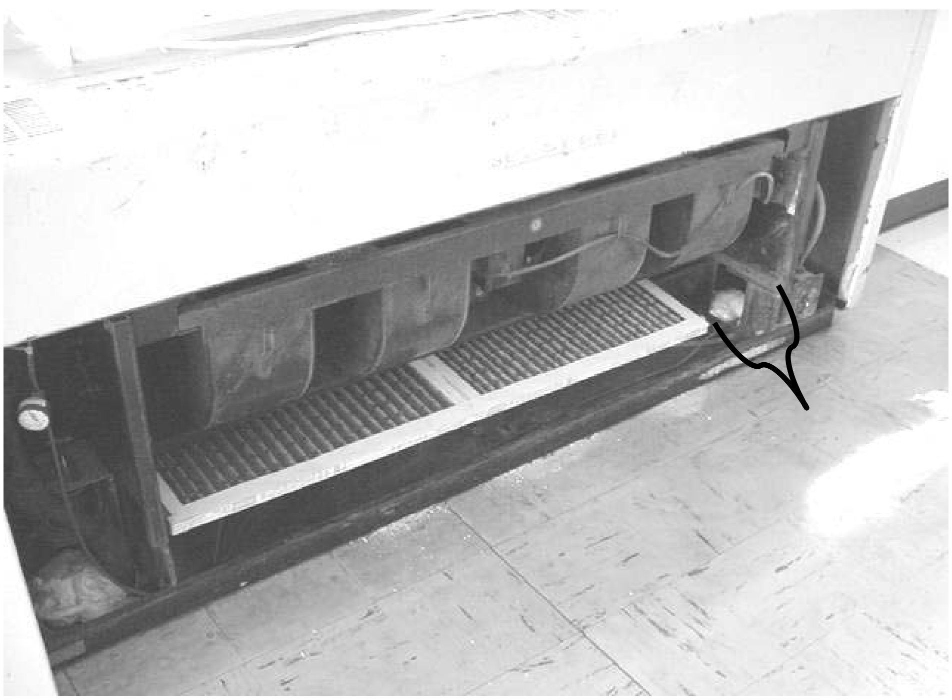
Damaged Glass Block Windows

Picture 12



Space beneath Window-Mounted Air-Conditioner

Picture 13



Short Filter Installed in Univent (Marker Indicates Space)

Picture 14

Holes in Univent Cabinet above Filter

Picture 15

Example of Bubbler Next To Exhaust Vent

Picture 16

Foam Insulation Injected into Univent Utility Pipe Holes to Seal Classrooms from Crawlspace